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The Determinants of Farm Investment and Residential Construction in Post-Reform China

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Forced consolidation of small Chinese farms into larger farms is unwarranted but China needs mechanisms to facilitate free-market land transactions, better supplies of such inputs as fertilizer, and — when those are available — a reoriented rural credit system. Early extensions of farmers' leases on state-owned land would reassure farmers about the government's commitment to the present system.

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This paper — a product of the Agricultural Policies Division, Agriculture and Rural Development Department -- is part of an effort to investigate rural credit markets, farm investment, and agricultural productivity in China. That research is part of a larger effort in PRE to determine how financial intermediation affects economic activities. Copies are available free from the World Bank, 1818 H Street NW, Washington DC 20433. Please contact Cicely Spooner, room N8-039, extension 30464 (35 pages).

After 20 years of collectivization, China's agricultural sector was reformed in the last decade. Individual farm/household units replaced collective production. Households were given individual leases on former commune land — first for 3-5 years, but now for 15 years, and even longer for tree crops.

Household data on four areas in China in 1987-88 revealed patterns of spending on productive assets, durable consumer goods, and housing.

Using a model of household production and investment decisions, Feder, Lau, Lin, and Luo analyzed data on several factors that had been thought to inhibit investment in farm capital and encourage residential or other nonfarm investments: the typically small size of farms together with increasing returns to scale in production; inadequate credit; and farmers' perceptions of insecurity because of possible policy shifts during the life of their leases on state-owned land or the likelihood of being assigned other lands when the contract matures.

What were the policy implications of the study results?

If the four study sites reflect the situation elsewhere in China, policymakers' preoccupation with issues of farm size and consolidation are unwarranted. The production gains from consolidation would be limited and the costs substantial.

Where farms are tiny, farm size is a problem -- but coercing consolidation or recollectivization would be harmful. It would be preferable to introduce institutional mechanisms and procedures to facilitate market-induced land transactions. More mobility of labor would also help.

Concerns about the inadequacy of investment finance for agricultural households are not yet justified in areas where the supply of such production inputs as fertilizer is unsatisfactory. But once the input supply system improves, limited credit will become a constraint — and the rural credit system, which is geared to rural industry and commerce, will have to be reoriented.

Radical revision of the land tenure system is not called for as the land leasing system seems not to be hampering investment. But likely erosion of investment incentives will be averted if leases are extended before they mature, reassuring farmers about the government's long-term commitment to the present system.

The Determinants of Farm Investment and Residential Construction in Post-Reform China*

by
Gershon Feder, Lawrence J. Lau,
Justin Lin, and Luo Xiaopeng

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I. INTRODUCTION

After twenty years of collectivized agriculture, China's agricultural sector underwent a major reform during the last decade. A key element of the reform was the introduction of the "household responsibility system", which replaced the collective production mode by individual farm household units. Households were given control over former commune land through individual contracts (initially for 3-5 years, but presently for 15 years with even longer periods for tree crops). Aside from a commitment to provide certain prespecified grain quotas at government-set prices, and the obligation to pay taxes, farmers now have the freedom to make cropping and input decisions, and are allowed to retain any profits which they earn.

The improved incentives brought about by the institutional reform, combined with higher prices for key agricultural products, induced an unprecedented acceleration of agricultural growth in China. Between 1979 and 1984 the value of agricultural output (in constant prices) grew at an average of 7.5 percent per year, mostly due to improved incentives (Lin, 1988; McMillan et al., 1989). After 1984, the pace of growth has slackened considerably, essentially because the potential gains due to improved incentives under the reformed structure were exhausted. Further growth thus depends on the traditional sources of agricultural development, i.e., further investment in physical capital, expanded material input supplies, and technological change.

In this context, the analysis of factors affecting farm investment in China is of much policy relevance. National data indicate that along with the reform in production organization, public sector investment in agriculture declined, in both absolute and relative terms. Agriculture's share in the government's capital

construction expenditure fell from 12.5 percent in 1979 to 4.6 percent in 1986. However, the reintroduction of compulsory labor services for maintenance of irrigation infrastructure was equivalent to more than half the state's budget for capital construction in agriculture during 1987. Information on farmers' farm investment is scant, but there are some indications of a response to the stimuli provided by the reform: in 1986 about 90 percent of the purchases of walking tractors, and a rapidly expanding share of truck purchases were by individual farmers. On-farm investment by farm households has likely been substantial, but it is not clear to what extent it has been overtaken by households' expenditure on non-productive assets (consumer durables and housing) and non-farm enterprises.

While the household responsibility system stimulated production incentives, it can be argued that concerns regarding the stability of the land tenure system introduced by the reforms, extremely small farm sizes, and credit inadequacies hinder farm investment, and may have caused a preference for investing in non-productive assets (e.g., housing) and in non-agricultural activities. Such arguments have been raised quite frequently by observers of Chinese agriculture, but there has been a paucity of empirical research to assess their validity and importance.

The objective of this paper is to clarify, on the basis of detailed farm level data derived from recent surveys, the importance of factors related to tenure security, farm size and credit availability in constraining farmers' agricultural investment. In particular, a direct measure of farmers' perceptions regarding tenure security will be utilized, as well as information on transactions in the credit market. The next section provides a description of the study areas.

it is followed by a discussion of factors affecting farm investment and a description of investment patterns in the study areas. A formal model of farmers' consumption and investment decisions, and an econometric analysis are then presented and results are interpreted. The last section summarizes the paper.

II. DESCRIPTION OF STUDY AREAS AND SURVEYS

The data underlying this study were obtained through recent farm surveys organized by the authors in four countries of China: Gongzhuling county in Jilin Province (December 1987). Tai and Jurong counties in Jiangsu Province (March 1988) and Xiajiang county in Jiangxi Province (November 1988). The samples consist of agricultural households, i.e., households operating farms as a major activity, as distinct from other rural households which engage in commerce or are mainly employed in rural industry.

Gongzhuling county is located in Jilin province of northeastern China. Agro-climatic conditions are such that only one crop season is feasible annually, and corn is the major crop grown. Farm sizes in the study area in Gongzhuling are large relative to typical farms sizes in China, and the significant surplus of output over consumption requirements makes the county a leading corn supplier in China.

Tai and Jurong counties of Jiangsu province are within the Central East China region where a two-season wheat-rice cycle is practiced annually. They are characterized by high population density and consequently have very small farm sizes. Many farmers in these counties supplement their income through off-farm

employment (mostly in township or village enterprises) or non-farm business activities.

Xiajiang county is located in Jiangxi province of Southern China where double-cropping of rice is predominant. The county is a major rice producer, with typical farm sizes double that of Jiangsu province. Farm fragmentation in the study areas in Jilin and Jiangsu province is less severe than the average for China (which is 9 tracts per farm). However, in Xiajiang county fragmentation is a serious problem, (an average of 16 plots per household) and in Jiangsu tracts are extremely small. Table 1 summarizes some key characteristics of the samples from the study areas.

The four counties covered by the study were purposefully selected from the national sample of 846 counties which are surveyed annually by the State Statistical Bureau. Each of the counties were deemed typical of the agro-climatic region in which it is located. The samples consisted of several randomly selected townships within each county, and within each township a number of randomly selected villages, with a total sample size of about 200 farmers per county. Both Gongzhuling and Xiajiang are surplus grain producing counties, while Tai and Jurong, where population density is very high, have less grain surplus as farm sizes area very small.

Farmers were asked in the course of interviews to provide information on their farm operations, assets (at present and in the past), credit market transactions, and perceptions regarding tenure security.

Table 1: Characteristics of Sample Farm Households

Item	County	Gongzhuling (N=200)	Tai (N=200)	Jurong (N=199)	Xiajiang (N=200)
1.	Mean farm size (Mu) a/	20.75	4.63	6.90	11.31
2.	Share of income from non-farm sources	18	47	47	15
3.	Per capita income in 1987/88 Yuan	952	737	832	472 b/
4.	Mean No. of land parcels per HH	3.7	7.05	4.90	16
5.	Main crop	corn (single season)	wheat (winter) Rice (Summer)	wheat (winter) Rice (Summer)	Rice (double cropping)

a/ 15 Mu = 1 hectare
b/ One season in 1988 only

III. FACTORS POTENTIALLY INHIBITING FARM INVESTMENT

A. Farm size. If production exhibits increasing returns to scale (at least within the relevant range), then larger farms will tend to have larger capital/land ratios, provided that supplies of other inputs or credit are not constrained.[1] Put differently, with increasing returns to scale the consolidation of farms would lead to higher investment and land productivity. Farm sizes in China are typically small even when compared to other Asian countries (.55 hectare per household is the national average), and their effective size is further diminished by fragmentation (the national average is about 9 parcels per farm). Some policy makers in China argue that the small farm sizes brought about by the shift into household-based production have hindered investment, and have called for partial recollectivization and consolidation.

The perception of increasing returns to scale relies in part on the observation that some capital goods are not divisible (e.g. tractors and draft animals). However, various arrangements have evolved in China's agriculture to circumvent this problem. In some areas, communal equipment and draft animals have been sold or assigned to selected households who committed to provide draft services to other farmers at agreed rates. In other areas, shared ownership of animals and equipment among several households is practiced.

B. Tenure security. Under the household responsibility system, farmers do not own the land, but have a lease protecting their use rights for the duration of the

[1] A sufficient condition for this proposition to hold when the production function is homogenous is that inputs are complementary in production (i.e., positive cross second derivatives).

contract. For most types of investments, a duration of 15 years as practiced at present may be viewed as sufficiently long to amortize animals and equipment. Uncertainty may however prevail in farmers' mind regarding the possibility that a change in government policy (whether at the central or local level) would lead into a reallocation, before the contract expires, of some or all of the land over which they hold a contract. If some or all of the land is taken away, farmers with excess capital may suffer losses even if the capital is mobile (i.e., not tied to the land). This is because of the transaction cost of liquidating capital. In addition to the risk of reallocation of land, farmers may be concerned about a possibility of a reversal of the individualization policy, leading to some form of consolidation and collective operation. This possibility entails uncertainties regarding the treatment of privately owned production capital. The risks outlined above can diminish the incentive to invest in farming capital (e.g., equipment, machinery and draft animals), but are less likely to affect investment in livestock (pigs, poultry, etc.) as these have a short payoff period and will most likely remain in private ownership regardless of policy changes.

Insights regarding farmers' tenure security perceptions can be derived from responses to specific questions pertaining to the possibility of land reallocation. These questions were included in the survey underlying the present study. As indicated in Table 2, in three of the counties studied, only a minority of the farmers perceive a high likelihood of land reallocation before the current contract expires. In contrast, in Xiajiang county three-quarters of the farmers expect land reallocation before the contract expires, i.e., a majority of the farmers in the county do not have much faith in authorities' commitment to the present allocation. This result is compatible with the fact that the survey in Xiajiang county took

Table 2: Farmers Perceptions Regarding Security of Tenure

Item	County Gongzhuling (N=200)	Tai (N=200)	Jurong (N=199)	Xiajiang (N=200)
% of farmers perceiving high likelihood of contract disruption before expiration date	17	17	24	75
% of farmers perceiving low likelihood of being reassigned the same farms after contract expiration date	85	76	78	59

place much later than in the other counties (November 1988). By the time of the survey, there have been several well publicized incidents in several areas of China during the second half of 1988 where local authorities forced consolidation of small farms. The changed insecurity perceptions in Xiajiang are not likely to have had an impact on the investment data underlying the present study, as these pertain to the period 1984-88.

A longer-term perspective underlies the responses to a question regarding the likelihood of being assigned the same tracts of land upon contract expiration. The majority of farmers in all counties perceive low likelihood of regaining use rights to the same tracts of land. While the risk of not being assigned the same parcels of land would clearly have a negative effect on land-embodied investment,

it may also hamper investment in mobile capital (e.g., machines), because uncertainty regarding reallocation of plots can imply also uncertainty regarding the future size of the farm and thus uncertainty regarding the marginal productivity of capital once the contract expires. However, when there is a relatively long-term land lease, concerns regarding future farm size would not have a strong impact on investment during the first years, as it will be fully or almost fully depreciated by contract expiration date.

Investment in housing is viewed by Chinese farmers as completely risk free, because houses have been privately owned even in the years of collective agriculture, and are likely to remain privately owned. It should be further noted that housing is a consumption item with high income elasticity. The income effect is augmented by demographic factors. In China's rural areas, a new house has become a precondition for marriage eligibility for young males. With the coming of age of individuals born in the baby boom of the early 60's, the demand for housing has increased. These facts, and the substantial pent-up demand due to the absence of any significant housing investment in the pre-reform years could produce a major adjustment in the housing stock once incomes have risen and private construction activities have become feasible.

C. Finance inadequacy. Credit constraints can be another factor inhibiting investment. Most investment outlays (and housing investment as well) tend to be lumpy, requiring a substantial amount of liquid resources. Because of this lumpiness, the necessary funds cannot typically be saved from one year's income, and long or medium-term credit, or accumulated savings, are needed to finance investment. Aggregate statistics indicate that the share of medium and long-term loans in the portfolio of the rural credit cooperatives (the main lending institution

dealing with agricultural households) is a mere 3 percent (World Bank, 1988a, p. 258). In the areas covered by the present study, the share of short term loans out of all institutional loans varies between 90 percent and 100 percent in the four counties (Feder et al., 1989). It is possible, of course, to finance investment by repeatedly rolling over short-term loans. In fact, the structure of interest rates in China provided incentives for such a rollover, as interest rates on short-term production loans were lower than interest rates on medium-term loans throughout the period under study (World Bank, 1988b, paper 7, annex 1, Table 10). However, short-term loans are typically granted in smaller amounts. Theoretically, when liquidity (and credit in particular) is fungible, a shortage of credit would affect all types of investment (whether productive or residential). However, deficiencies and segmentation (by source and purpose) of credit markets could create a situation whereby funds which are available for housing investment cannot be used for productive investment. An assessment of the operation of credit markets in rural China is thus necessary in order to determine the role of credit constraints in explaining the observed investment patterns.

Sources and uses of credit in the study areas are presented in Table 3, which describes the composition of loans undertaken by sample farmers in the most recent season prior to the interview. The bulk of institutional credit is declared to be destined for production (input purchase) as is indeed intended by government's policy. However, most institutional credit is de-facto fungible, regardless of the stated objectives for which it is acquired, and it is likely that short-term production credit could be used to finance investment in farm capital or housing. The extent to which rolled-over short-term institutional credit could substitute for medium and long-term funds is probably limited, because amounts

are typically small, and the need to repeatedly roll over the loans introduces an element of uncertainty and inconvenience.

In rural China, non institutional credit is less likely to be fungible, because it is granted mostly free of interest by relatives and friends, who have close knowledge of the activities and financial resources of the borrowers. Unlike institutional credit, which is by-and-large short-term, informal credit in the study areas is mostly medium and long term, or has no definite maturity date (Feder et al., 1989). It is likely that relatives and friends are more inclined to lend money for purposes of house construction and special social events (e.g. weddings) which are perceived as a basic need deserving assistance. They are less likely to provide interest-free loans for agricultural investment which is undertaken for the purpose of increasing the borrower's income. Table 3 indicates that a higher share of non-institutional credit is devoted to purposes not related to production, and a significant proportion of it is used to finance construction rather than productive investment. Because of their ability to monitor borrowers activities, loans acquired from relatives and friends are typically used for the specific purposes for which they were granted, and thus do not add to overall liquidity. It is therefore expected that informal credit is not available as a significant source of funding for farm investment in the study areas.

Table 3: Distribution of Loan Purposes by Type of Lender (Percent)

County and Source	Purpose	Sample Size (loans)	Production	Farm Machinery	Construction	Consumption	Social (Wedding, Funeral, etc)	Other
Gongzhuling								
	Institutional	212	93.0	4.0	2.0	0	1.0	0
	Non-Institutional	47	11.0	4.0	23.0	15.0	26.0	21.0
Tai								
	Institutional	57	89.0	2.0	4.0	0	0	3.0
	Non-institutional	25	36.0	0	32.0	0	20.0	12.0
Jurong								
	Institutional	29	48.0	10.0	10.0	3.0	10.0	19.0
	Non-Institutional	31	6.0	19.0	29.0	13.0	23.0	10.0
Xiajiang								
	Institutional	158	67.9	3.8	5.8	1.3	8.4	14.8
	Non-Institutional	85	33.8	1.5	28.0	9.2	20.0	9.5

IV. PATTERNS OF INVESTMENT AND EXPENDITURE ON HOUSING AND DURABLES IN THE STUDY AREAS

The implementation of reforms in China's agricultural sector coincided with other economic changes which made various consumer goods more available in both urban and rural areas. Thus the increased incomes and savings could be used for acquisition of consumer durables, an expense of significant magnitude relative to typical farm incomes. Table 4 compares ownership of several major consumer durables (T.V.,radio/tape, bicycle, sewing machine, watch) at two points in time: 1983, which in the study areas was a year when the new production mode was at initial stages of implementation, and 1988 (or 1987 in the case of Gongzhuling) when the reform was well in place, and farmers had already benefitted from several years of higher incomes. All items show significant increases. The most remarkable change occurred in ownership of T.V.'s which increased by hundreds of percent in all counties. Consumer durables are obviously private property which will not be affected by any changes in government's policies in the agricultural sector.

Investments in productive farm assets have been substantial, compared to initial levels of capital in the study areas. As demonstrated in Table 5, capital stocks (livestock and equipment) have more than doubled in the 4-5 year period covered by the data, implying annual growth rates of capital exceeding 15 percent.[2] This represents significant real growth, as the price index of agricultural equipment rose by only 15 percent over the whole period covered.

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[2] The survey covered several types of land improvements, such as clearing of stumps and constructing bunds, but there was little variation in the data as most of these improvements were already undertaken before the reforms. Other types of improvements were difficult to quantify.

As one would expect, the highest volume of investment per household took place in Gongzhuling and Xiajiang where farms are larger.

Table 4: Changes in Ownership of Consumer Durables in Study Areas

County, Year	Gongzhuling (N=200)		Jurong (N=199)		Tai (N=200)		Xiajiang (N=200)	
tem	1983	1987	1983	1988	1983	1988	1983	1988
Own T.V.	6	42	11	38	2	26	5	48
Own radio/tape	3	14	2	17	2	12	34	44
g. no. of bicycle	.62	.98	1.14	1.33	1.10	1.43	1.02	1.26
own sewing machine	46	57	22	37	11	38	10	19
own watch	64	83	68	94	53	91	59	82

Table 5: Cumulative Productive Investment in the Period 1983-1988 [a/] (sample means in Yuan)

Item	County	Gongzhuling (N=200)	Jurong (N=199)	Tai (N=200)	Xiajiang (N=200)
Crop-related investment					
(i)	Tractor	309	139	0	95
(ii)	Other equipment	173	82	42	127
(iii)	Draft animal	200	76	12	357
Sub-total		682	297	54	579
Other Productive Investment					
(i)	Truck/boat	120	0	123	0
(ii)	Livestock	104	214	150	556
Sub-total		224	214	273	556
Total Productive Investment		906	511	327	1135
Total productive investment as % of initial capital		159%	127%	131%	107%

a/ Figures for Gongzhuling are for the period 1983-1987, while the figures for other counties pertain to the period 1984-1988. The figures are undeflated. The price index for agricultural equipment increased by 15 percent between 1983/4 and 1987/8.

The composition of investments differs across the counties studied. Food animals (pigs, chicken) are a major component of investments in Xiajiang and Tai county. Draft power (mechanized or animal) composes over one half of the investment in Gongzhuling, where farm sizes are the largest among the study areas. In Tai county, where canals are numerous, farmers invest in boats (which are used for transportation). The figures reported for investment in tractors and trucks may be misleading, because tractors are expensive and they raise the sample mean significantly even though only a few households have acquired them. For this reason it is useful to observe the changes in the frequency of ownership for different capital items, reported in Table 6. It is noted that even in Gongzhuling, less than 10 percent of the households own tractors. The most common form of investment is in pigs, which constitute in all counties except Gongzhuling about 40-50 percent of productive investment.

Investment in house construction or housing improvement is a major form of asset accumulation for farmers in China (Tam, 1988). Table 7 describes several types of housing improvements undertaken by sample farmers, such as the installation of tile or tin roofs instead of straw, and the replacement of dirt floors by concrete.

Significant improvements are observed in housing standards in all study areas, and about half of the sampled farmers indicated that they have invested in housing improvement or expansion since 1983. The volume of funds invested in housing improvement is substantial. On average, the outlay on house improvements for households undertaking such improvements was more than their average annual income, exceeding productive investment by a wide margin (last line in Table 7). The share of housing investment in the total outlay on productive investment and

housing improvement ranges from 64 percent in Xiajiang to 91 percent in Tai county.

Some possible reasons for the heavy investment in housing, which are not related to any of the factors potentially inhibiting productive investment, have already been mentioned in section II above (e.g., demographic trends and high income elasticity). But it is also possible that some of the factors hampering incentives for productive investment induce an asset composition more heavily dominated by residential capital (e.g., limited tenure security, segmented credit markets, and small farm size). These issues need to be investigated empirically, but prior to the econometric analysis a formal model needs to be presented to underly the empirical work.

Table 6: Changes in Productive Assets

% Who Own	Gongzhuling (N=200)		Tai (N=200)		Jurong (N=199)		Xiajiang (N=200)	
	1983	1987	1983	1987	1983	1987	1984	1988
Tractor	1	9.5	0	0	3.5	8.0	4.0	5.5
Truck/boat	0	0.5	4.5	26.0	0	0	0	0
Pump engine	1	2	0	1.5	6	11.5	0.5	1.5
Thresher	0	3	0	0.5	2.5	12	92.0	97.0
Buffalo/oxen	5	19	0	3.0	53	77	94.5	92.5
Pigs	81	66	86.5	66.5	85	84.5	97.5	98.5
Other animals	15	30	.5	0	1.5	0	0.5	0.5
Average value per household (yuan) a/	570	1476	250	577	403	914	1060	2195

a/ The values are not deflated. The price index for agricultural equipment rose by 15 percent between 1983/4 and 1987/8.

Table 7: Improvements in Housing

County, Year	Gongzhuling (N=200)		Jurong (N=199)		Tai (N=200)		Xiajiang (N=200)	
tem	1983	1987	1983	1988	1983	1988	1983	1988
with non-straw roof	22	51	94	98	51	85	99	99
with non-earth floor	11	23	12	27	15	44	14	36
with non-earth wall	22	48	85	95	51	85	69	80
who invested in housing rovement since 1983	60		47		68		46	
g. size of housing nvestment (Yuan) a/	4,135		3,792		5,233		4,506	
Ratio of housing improvement nvestment to productive nvestment b/	2.71		3.57		10.88		1.82	

/ Calculated for the subsample of individuals with housing improvement.
Calculated for whole sample.

V. A Model of Household Consumption and Investment

Consider a household maximizing its utility over a two-period planning horizon. Utility is defined over a composite consumption good (C) and over housing services (H). For simplicity, we assume separability of utility.

$$T = U_0(C_0) + V_0(H_0) + U_1(C_1) + V_1(H_1) \qquad (1)$$

where T is total utility, U and V are respectively the utilities from composite consumption and housing services, and the numerical subscripts denote time periods. The time discount factor is omitted for simplicity, as it can be embodied in the definition of U_1 and V_1.

The household has an initial endowment of financial resources W_0, which is augmented with borrowed funds L. These resources can be used in the first period for consumption (C_0), investment in productive assets (I) and investment in housing (h). Other initial endowments are capital (K_0), land (A_0) and housing (H_0). These are assumed illiquid and cannot therefore be used for financing consumption or investment. The budget constraint is given by

$$W_0 + L = I + h + C_0 \qquad (2)$$

In the second period, if no change in the land endowment occurs, the augmented capital stock (that is, initial capital plus first period investment) is combined with the initial land endowment to produce output via a neoclassical production function. Consumption in the second period is then the value of output minus the debt repayment. However, if agriculture is recollectivized or the land is taken away (an event with probability P), then the farmer receives only

some fixed future income Y, all debt is cancelled, and production capital is taken over by the state. [3] Second period consumption is therefore

$$C_1 = F(K_o + I, A_o) - (1+r)\cdot L \qquad \text{with probability } 1-P \tag{3}$$

$$C_1 = Y \qquad \text{with probability } P \tag{4}$$

where F is the production function and r is the interest rate.

Maximization of the expected value of utility subject to equations (2), (3), (4) is equivalent to

$$\underset{I,h}{\text{Max}}\ U_o(W_o+L-I-h) + V_o(H_o) + (1-P)\cdot U_1[(F(K_o+I,A_o) - (1+r)\cdot L)] + P\cdot U_1(Y) + V_1(H_o + h) \tag{5}$$

First order conditions for optimum require

$$-U_o' + (1-P)\cdot U_1'\cdot F_K = 0 \tag{6}$$

$$-U_o' + V_1' = 0 \tag{7}$$

where F_K is the marginal productivity of capital.

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[3] The model could be formulated with a less extreme scenario whereby there is a probability of losing only a portion of the land and a portion of capital. While the mathematics would be more tedious, the results would be similar.

Comparative static results generated by the model are summerized in Table 8. Proofs can be provided by the authors to interested readers.

Table 8: Comparative Static Results

Effect on Change in	Productive Investment I	Housing Investment h
Credit (L)	+	+
Risk (P)	-	+
Initial Productive Capital (K_o)	-	+
Initial Housing (H_o)	+	-

The effect of additional credit on both types of investment is positive, as one would expect when the liquidity constraint is binding. An increased risk to land rights will lead to less farm investment and higher residential investment. Higher initial stocks of productive capital and housing have a negative direct effect on investment in these items, but positive cross-effects.

The effect of farm size is not easy to ascertain in the context of the present model. Typically a larger farm size is also associated with a larger allocation of credit, thus a ceteris paribus change of farm size is not meaningful. It can be shown that if returns to scale are increasing, or if the marginal utility of consumption is relatively non-elastic, then it is more likely that farm size is

positively related to investment. If credit and variable input supplies are not constrained (i.e., treating L as a decision variable in the preceding mathematical model), then increasing returns to scale imply higher capital/land ratios. However, if some inputs are fixed (e.g., rationed fertilizers) and their supply increases less than propoetionately with farm size such that production is conducted under de-facto decreasing returns to scale, then optimal capital/land ratios will decline with farm size even if credit is not a constraint.

VI. Econometric Results

The first empirical issue which needs to be clarified relates to returns to scale. Proponents of consolidation and recollectivization assume that there are increasing returns to scale in Chinese agriculture. Investment and productivity would thus be enhanced if typical farm sizes were larger. In order to estimate the returns to scale in agricultural production within our study areas, conventional Cobb-Douglas production functions were estimated (Table 9). The output in these functions relates to crops but excludes livestock products, as livestock activities (poultry and pigs) are not directly related to farm size. Corresponding to this notion of output, the measure of capital utilized includes the value of equipment, machinery and draft animals, but excludes the value of other livestock.

The estimates indicate that in the two counties with larger farm holdings (Gongzhuling and Xiajiang), production can be characterized by constant returns to scale, as the sum of production elasticities does not differ significantly from 1 (line (g). In the two counties with small farm sizes (Tai and Jurong) returns to scale are statistically significantly larger than 1. Tai county, with the smallest

Table 9: Estimates of Production Functions
(Cobb-Douglas Specification)

Input	County	Gongzhuling (N=200)	Jurong (N=190)	Tai (N=200)	Xiajiang (N=196)
(a)	Land	.732*	.651*	.661*	.508*
		(14.738)	(10.287)	(7.924)	(7.872)
(b)	Capital	.015*	.020	-.005	.067*
		(1.816)	(1.345)	(.621)	(3.049)
(c)	Labor	.055	.285*	.393*	.263*
		(1.279)	(4.735)	(5.216)	(4.625)
(d)	Nitrogen	.147*	.086*	.044	.131*
		(4.074)	(2.691)	(1.364)	(4.382)
(e)	Manure	.029*	.015	.018	.004
		(2.592)	(1.190)	(1.056)	(.326)
(f)	R^2	.921	.903	.945	.900
(g)	Returns to scale	.977	1.056	1.116	.975
(h)	t value of test for returns to scale different from 1	.759	2.022*	4.08*	.800

* Significant at a one-tailed 95 percent confidence level.

Notes: General: Other variables in the equation include a constant, village dummy variables, an indicator for production problems such as pest, and human capital (age, education). The parameters are not presented.

(a) Land is measured as a combined area of all parcels, adjusted for quality differences through an index based on parameters from a hedonic value equation.
(b) Capital is measured as the value of cropping-related equipment, machinery and draft animals.
(c) Labor is measured as the actual days applied, with the weights of 1.0, .75,.5 for males, females, and children respectively.
(d) Nitrogen is measured as weight of pure nutrient.
(e) Weight of manure.
(g) Sum of coefficients (a)-(e).
(h) Test against the null hypothesis that returns to scale are constant.

mean farm size (less than 1/3 hectare) has the highest estimated returns to scale (1.116). In Jurong county the returns to scale are 1.056. These results are thus compatible with the observation that capital indivisibility implies increasing returns to scale within a range of smaller farm sizes.[4] The demand for cropping-related capital in the counties with very small farm sizes is thus smaller by more than a proportionate factor as compared to a hypothetical region with identical agro-climatic conditions but larger farm sizes. Furthermore, the estimated production elasticity of capital in the two counties (Tai and Jurong) is not significantly different from zero. This suggests a low marginal productivity of capital in crop production, apparently due to the indivisibility of capital and the very small size of farms.

We proceed next to analyze the determinants of investment in productive assets. In order to allow for a better correspondence between the tenure security variables and the type of investment considered, only investment in cropping-related capital is considered (e.g., livestock is excluded). The estimated model corresponds to the reduced form of the system of first-order conditions (6) - (7) as summarized in Table 8, with modifications to allow for a somewhat richer model. One modification is the inclusion of a third form of investment, namely, non-crop-related capital, in addition to housing and crop-related capital. Its effect on crop-related investment is expected to be in the same direction as housing (i.e., positive). While values of housing in the beginning of the period (H_0 in the notation of the preceding section) were not available, indicators of housing quality in 1982 were used to construct a composite index of initial house quality.

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[4] A study employing province level time series data for the period 1984-1988 obtained an estimate of returns to scale of 1.07. See Lin (1989).

Other modifications involve the inclusion of several household characteristics: Family size adds to housing demand and is thus expected to negatively affect productive investment. The number of adults (proxi for household labor endowment) reduces the demand for hired labor and thus releases more liquidity for productive investment when credit is a binding constraint. Two variables were incorporated in the analysis to represent human capital: Education and experience in agriculture. The latter variable is significantly correlated with age, and may thus represent several factors with differing impacts on investment (e.g., older farmers may be less inclined to invest). Farm size was adjusted for land quality differences through a hedonic quality index. A coefficient greater than 1 would imply increasing capital/land ratios.

The probability of land loss is represented by two indicators of confidence in the present land allocation system constructed from farmers' perceptions as reported in section III. One indicator relates to perceived likelihood of contract disruption in the short term, while the other refers to the likelihood of retaining the same farm in the longer-run. Both indicators were constructed as dummy variables where the value 1 implies more tenure security and 0 implies less tenure security, thus the expected sign is positive if land tenure considerations significantly affect investment.

Given the segmentation of formal and informal credit markets as discussed in section III, a distinction was made in the empirical analysis between the two types of credit, so as to test whether they have separate effects on different investments. Specifically, informal credit is not expected to significantly affect productive investment, as it is not typically provided for such purposes and it is mostly not fungible. Because institutional credit is mostly short-term, the average

annual institutional borrowing by the household was utilized in the analysis, while for informal credit the cumulative amount for the period was used. A positive coefficient is expected if credit is a binding constraint.

Two sets of estimates were obtained: OLS regressions of crop-related capital stock, and Tobit estimates of investment in housing. The capital regressions, reported in Table 10, indicate that the stock of capital increases with farm size (parameters in all counties are significantly greater than zero at a 95 percent one tailed confidence level). Only in the case of Gongzhuling does the capital/land ratio increase with farm size, as the coefficient of land is greater than 1. However, one cannot reject the hypothesis that the capital/land ratio is fixed in Gongzhuling, ceteris paribus (i.e., that the coefficient of land is equal to 1). Similarly, in Tai county the hypothesis that the coefficient of land is one cannot be rejected. In Jurong and Xiajiang counties, the coefficients of land are significantly less than 1, indicating that larger farms have lower capital/land ratios. This may be due to supplies of rationed variable inputs (e.g. fertilizers) increasing less than proportionately with farm size, or due to less than full utilization of capital (a consequence of indivisibility). The latter explanation is compatible with the non-significant production elasticity of capital in Jurong county.

Informal credit does not affect investment in crop-related capital in any of the counties (none of the estimated parameters are statistically significant at the 95 percent confidence level). This is compatible with the segmentation and lack of fungibility characterizing this source of funding. Formal credit significantly and positively affects investment in farm capital in Gongzhuling county,

Table 10: Regressions of Crop Related Capital Stock

Variable [a]\County		Gongzhuling (N=200)	Jurong (N=190)	Tai (N=200)	Xiajiang (N=196)
I.	Farm Size	1.548	.383	.560	.452
		(4.491)	(2.288)	(1.795)	(3.264)
II.	Credit				
	Formal credit	.170	-.004	.001	.004
		(2.068)	(.950)	(.024)	(.138)
	Informal credit	.035	.001	.021	.025
		(.891)	(.079)	(.680)	(1.917)
III.	Security Perceptions				
	Confidence in short-term	-.121	.173	-.359	.174
		(.310)	(1.013)	(1.136)	(1.546)
	Confidence in long-term	.382	.083	-.108	.015
		(.910)	(.499)	(.317)	(.132)
IV.	Initial Capital Stocks				
	Crop related capital	.182	.214	.256	.230
		(1.980)	(3.800)	(2.549)	(3.492)
	Non-crop capital	.060	-.044	.098	-.015
		(.672)	(.768)	(1.054)	(.205)
	Housing quality	-.219	-.160	.107	-.015
		(1.446)	(1.298)	(1.103)	(.190)
V.	Household Characteristics				
	Family size	.143	.234	.625	.239
		(.240)	(.711)	(1.433)	(1.322)
	No. of adults	.052	.344	.226	.202
		(.112)	(1.159)	(.635)	(1.424)
	Education	.026	.017	-.015	-.023
		(.449)	(.742)	(.489)	(1.547)
	Experience	.001	.001	.002	-.009
		(.725)	(.725)	(.307)	(1.996)
	R^2	.446	.290	.616	.523

a/ A constant term and village dummy variables were also included in each regression, but are not reported here. Regressions follow a double logarithmic specification. Sample sizes differ due to missing observations.

Table 11: Proportion of Farmers with Unsatisfied Input Demand (Percent)

Input \ County	Gongzhuling (N=200)	Jurong (N=199)	Tai (N=200)	Xiajiang (N=200)
Fertilizer	10	54	14	23
Diesel	10	33	29	67
Pesticides	1	32	23	23
Herbicides	1	28	26	29

Note: The numbers show the percentages of respondents who stated that they were not able to obtain the desired quantities of inputs even though they were willing to pay higher than market prices.

Source: Feder et al., 1990.

where input supply problems are negligible and farm sizes are larger. In the other three counties formal credit does not significantly affect investment, and it would thus seem that generally credit was not a binding constraint on crop-related investment in these counties. In Tai and Jurong counties, demand for investment has likely been low due to the low marginal productivity of capital and small farm sizes. In Xiajiang county farm sizes are larger, but inadequate input supplies are a serious problem, apparently diminishing the profitability of, and hence the demand for, farm capital.

Concerns regarding land reallocation did not hinder productive investment significantly (none of the coefficients are statistically significant). This is, apparently because farmers expected (at least at the time of the survey) that the

general household responsibility production mode will prevail, and may have perceived the transaction costs of capital stock adjustment which will be incurred upon reallocation to be minor.

The parameter of the initial stock of capital is significantly greater than zero and smaller than 1 in all counties. Other variables in the equations, however, are not significantly greater than zero.

Tobit estimates of the parameters of demand for housing investment are presented in Table 12. In all counties the parameter of informal credit is significantly related to housing investment, implying that the availability of informal credit was a binding constraint on housing investment. In Xiajiang county formal credit was also a significant factor affecting housing investment, and in all other counties the parameters of formal credit are positive, although not statistically significant. Tenure security perceptions do not affect housing investment, except in Xiajiang county, where a counter-intuitive sign is observed for the long term tenure security indicator. As expected, initial housing quality is significantly negataively related to housing investment (except in Xiajiang county). Education is positively related to housing investment in three of the counties, perhaps because it is a proxi for political status and better access to construction materials.

Table 12: Tobit Estimates of Investment in Housing

Variable [a]\County	Gongzhuling (N=200)	Jurong (N=190)	Tai (N=200)	Xiajiang (N=195)
I. Farm Size	8.890	-67.539	226.978	52.380
	(.210)	(.486)	(.778)	(.445)
II. Credit				
Formal credit	.612	6.843	2.965	4.559
	(1.037)	(1.324)	(.329)	(2.666)
Informal credit	.803	1.338	1.537	3.369
	(3.272)	(5.200)	(5.241)	(7.664)
III. Security Perceptions				
Conf. in short-term	-763.506	-550.699	1233.640	-1613.080
	(.802)	(1.407)	(.432)	(1.256)
Conf. in long-term	46.281	-856.118	-1570.250	3584.130
	(.046)	(1.030)	(1.187)	(2.886)
IV. Initial Capital Stocks				
Crop related capital	.008	-.731	11.811	1.770
	(.016)	(.882)	(1.517)	(2.100)
Non-crop capital	7.219	.981	-1.379	4.449
	(5.109)	(.693)	(.617)	(1.583)
Housing quality	-1890.98	-1195.130	-1140.37	-948.705
	(4.710)	(1.963)	(2.822)	(1.148)
V. Household Characteristics				
Family size	87.323	162.489	571.999	265.222
	(.242)	(.390)	(1.269)	(.616)
No. of adults	25.197	752.566	-230.057	-89.100
	(.069)	(1.697)	(.501)	(.203)
Education	257.485	-209.292	400.977	353.298
	(1.873)	(1.826)	(3.019)	(2.172)
Experience	-18.805	-29.328	-13.975	-29.625
	(.589)	(.960)	(.407)	(.585)
Log-likelihood	-1198.8	-957.2	-1374.3	-942.10

a/ A constant term and village dummy variables were included in each equation. sample sizes differ due to missing observations.

VII. SUMMARY AND CONCLUSIONS

The data and analysis presented in the preceding sections, while pertaining to only four counties within China, generate plausible conclusions with likely applicability to other areas. The data confirm the well established upsurge in acquisition of consumer durables and residential investment in rural areas. It is also demonstrated that productive investment was substantially lower than investment in housing, raising the question of whether there were factors which inhibit productive investment, thereby encouraging other investments. Possible constraints which were suggested by scholars of Chinese agriculture include the small farm sizes, insecure land tenure and inadequacy of financial arrangements. All of these potential constraints can be neutralized through policy, but any policy change involves direct and indirect costs, and it is therefore important to identify which of the constraints are actually significant and under what circumstances.

The analysis shows that the extremely small size of farms in some areas could become a factor hindering investment and productivity, as the indivisibility of capital introduces increasing returns to scale. The emergence of some forms of customized draft services or shared ownership of capital assets has apparently not been sufficient to overcome the problem of indivisibility. The impact of increasing returns to scale has not been reflected in the investments in the areas characterized by very small farm sizes, because other inputs (e.g., fertilizers, diesel, herbicides) are possibly rationed in a manner not proportionate with farm size, or because capital is underutilized in areas where most farms are below a threshold size. If, however, the problem of supplementary inputs supplies is rectified (e.g. by introducing market mechanisms to the distribution system), then

a likely outcome is an investment pattern where larger farms have higher capital/land ratios, unless the availability of financing becomes a binding constraint. Under circumstances of inadequate variable input supplies, the depressed demand for capital is reflected in a lower demand for credit. Consequently, in the three study areas where input supply problems were severe, credit was not a factor inhibiting investment in crop-related farm capital. In the one province with adequate input supplies, crop-related investment was constrained by the supply of institutional credit. In such an area, the estimates suggest that a doubling of the volume of institutional credit (which is officially intended mostly for financing of current inputs) would increase capital stocks by 17 percent. An increase of one dollar in the availability of formal credit to an average household would lead to 40 cents of additional investment.

Insecurity of land tenure, stemming from the absence of private ownership and apprehension regarding disruption of the existing land allocation, does not appear to have been a significant factor affecting investments before 1989. However, as current land contracts were awarded for 15 years, investments in the years past the mid-point of contract maturity (i.e., towards the mid 90's) may be more sensitive to perceptions regarding land reallocation. Since the data show that the majority of farmers think it is likely that they will not be allocated the same parcels of land upon contract maturity, this issue is potentially significant and requires remedial policy (e.g., by extending current contract maturities several years before they expire).

A reform in the input supply system is likely to increase the demand for investment, and credit may therefore become a constraint in areas where it is presently not inhibiting investment. The institutional credit system is highly

centralized and controlled (although reforms are being gradually introduced), and a market-induced supply response is not likely. The non-institutional credit market is highly segmented. For agricultural households, most informal credit is obtained from relatives and friends, and is not available for farm investment. An institutional credit expansion will likely need to augment an input supply policy reform to facilitate both increased input use and increased farm investment.

Farm size is a factaor limiting investment in areas where farms are extremely small. Solutions in the form of forced consolidation have serious repercussions (e.g. undermining of tenure security perceptions). If consolidation also involves some forms of recollectivization, then serious incentive problems will re-emerge, with significant productivity losses (Lin, 1990). Similarly, publicly maintained equipment rental or custom services have a mixed record in other countries. The increased supply of mechanized equipment designed for small scale farms may alleviate some of the farm scale problems. Market-induced farm consolidation may emerge if alternative employment in the rural sector becomes an attractive option for agricultural households and if constraints to labor mobility are removed. Such a process would require the elimination of various bureaucratic obstacles to land market transactions. Thus, while rental of land is now allowed among individuals, the actual legal and bureaucratic mechanisms to facilitate efficient land markets have not been implemented, and apprehension regarding land contract cancellation upon renting-out may still be a factor.

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